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Forest Service

Forestry Research West

March 1989

A report for land managers on recent developments in forestry research at the four western Experiment Stations of the Forest Service, U.S. Department of Agriculture.

Forestry Research West

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Cover

Using chemical fertilizer to help control the western spruce budworm? Scientists at the Pacific Northwest Station believe it may be possible. Find out how, beginning on page 9 .

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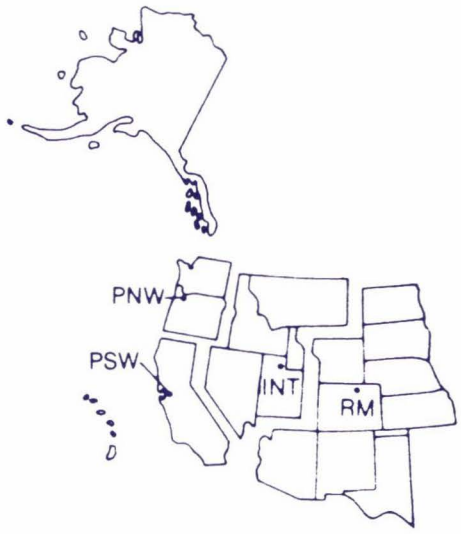

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EXPERIMENT STATION

What we're learning about the woodlands

by Elizabeth Close
Intermountain Station

Managing pinyon and juniper woodlands used to be a breeze—you'd stretch a heavy anchor chain between two caterpillars and drive along uprooting all the trees in your path. Such chaining operations converted the "scrubby" landscape to rangelands more suitable for livestock grazing. But wood products have dramatically increased in value, making multiple use management practical for woodland sites. Scientists at the Intermountain Research Station in Reno, Nevada are developing alternative management strategies for these woodlands. Their work has brought new understanding of this often-overlooked landscape.

Pinyon and juniper woodlands occupy more than 47 million acres in the western United States. Woodlands occupy the foothills, low mountains, and plateaus at elevations of 4,000 to 8,000 feet between the sagebrush valleys and the forested upper slopes. Woodland tree and understory species change from the Southwest into the Great Basin and on to the Pacific Northwest. The Intermountain Station's Pinyon and Juniper Ecology Project works primarily with woodlands occupying 17 million acres in the Great Basin. Here singleleaf pinyon and Utah juniper are the primary tree species, and the understory is dominated by shrub species—sagebrush, bitterbrush and snowberry.

The growth rate of young pinyon trees is monitored during revegetation projects.

Past use and abuse

These lands have been used by people for the past 20,000 to 30,000 years. Native Americans of the Great Basin relied heavily on pinyon nuts for food, and trees for fuelwood and building material. Early settlers had high regard for the woodlands, adding the traditional Christmas tree to the growing list of uses.

The 1860 mining boom in Nevada had the single greatest impact on Great Basin woodlands. Requirements for fuelwood to smelt the ore were staggering, and woodlands around mining towns were denuded of trees—stumps were even dug out of the ground. Demand for fuelwood and fence poles continued after mining declined. It wasn't until after World War I that the Great Basin became dependent upon fossil fuels for energy, and the woodlands were forgotten.

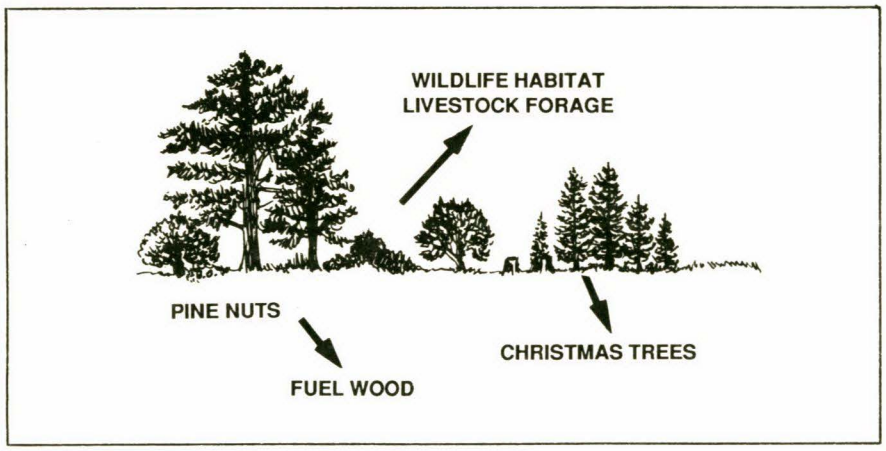
The woodlands were forgotten but not inactive. Trees rapidly reestablished on past sites and encroached into adjacent shrublands. Through fire prevention man protected the woodlands and accelerated their expansion. Tree encroachment and the subsequent loss of wildlife habitat have become a serious regional problem.

"Because of past use, abuse, and then neglect, what we see now is a drastically altered system," said Intermountain Station Project Leader Richard Everett. "The capability of the closed woodland to respond to disturbance isn't there any more. Trees are superior competitors that kill understory plants and reduce soil seed reserves to the point that

plant response following disturbance is often unwanted wood species such as cheat grass or prickly poppy. Areas that have the potential for a variety of wood products and wildlife values may have a difficult time getting back into a desirable woodland condition."

"We have found custodial and protective management does not work", Everett said. "When protected past a critical stage, the woodland ecology is disturbed. Woodlands are dynamic and change under passive management. Under active management we can drag trees down with a chain to keep them from marching across the landscape. But that wastes the wood resource. Past decisions to convert woodlands to grasslands were often based on short-term economic gains and not what was the best use for the site. All woodlands are not created equal; in fact, all wooded sites are not woodlands."

"The key is to manage in line with the natural potential of the site. We've helped land managers determine this by developing a classification system for pinyon-juniper types. The classification links vegetation units to resource potentials so that land managers can make decisions on the priority use for a site.



Wise management of natural succession in pinyon-juniper woodlands yields multiple cash crops and forage.

A nonclassic classification

Classification systems are normally based on the plant association at the terminal stage of the succession. "In many of these woodlands the normal definition of the association-tree layer, shrub layer and grass layer is impossible because of the loss of the understory component", said Everett. "The level of disturbance and understory exclusion is so widespread that we don't have any relic sites to study to define what the association should be. Rather than guess at what the non-existent herbaceous layer should be, we opted for a modified classification approach that emphasizes the more persistent shrub layer and defines woodland classification units by shrub seres."

The classification system is regionalized for the Great Basin, and even more specifically for the Reno floristic section within that division. Scientists began looking at 68 shrub species, then distilled the classification down to 13 indicator shrub species. They developed a field key for on-site shrub group identification, and have been testing the key in woodlands previously unsampled.

"Using the key, we get 90 percent or better correct site classification," said Everett. "It works."

Everett anticipates some will question the shrub sere classification approach.

"Classification is not a science; it is simply a point of view," he said. "Most classification systems emphasize hierarchical relationships. Our emphasis has been to help land managers recognize what's on the ground and what can be done with it."

It is not the purpose of research to classify the landscape. Our responsibility is to come up with a classification procedure of value to land mangers, and that's what we've done. I'm not touting this approach over any other. Hopefully, it will give us a basis for land management decisions and a common means of communication about woodland types."

The plan for information transfer

The value of the key will be tested when it is used in a Pinyon and Juniper Practitioners Workshop next May. Sponsored by the University of Nevada, Nevada Division of Forestry, Bureau of Land Management, and the Forest Service, the workshop is designed to provide an intensive update on pinyon-juniper management. Classification is one of five subject areas emphasized; others include inventory, product potential, treatments, and monitoring. Mike Hanson, Intermountain Region State and Private Forestry, is coordinating registration for the workshop.

"We've gotten a lot of response," said Hanson. "I think that's a sign of the elevation in the level of interest and care about these woodlands. Maybe someday we'll even see manager expertise similar to what has been developed through silvicultural certification in conifer types. That day is still a long way off in pinyon-juniper, but now is not too soon to be laying the management foundation."

The workshop is the final step in a process of information development and dissemination that began in 1985. That year saw the formation of an interagency steering committee to develop and organize the state-of-the-art information on pinyon-juniper woodland management.

"The approach selected was to hold a West-wide pinyon and juniper conference to gather the required information, develop a management guide from the conference papers, and hold field workshops utilizing the management guide," said Everett, "and that's exactly what we did."

The West-wide information gathering conference was held in Reno in 1986. The 581-page proceedings, *Proceedings—Pinyon-juniper Conference*, published as Intermountain Research Station General Technical Report 215, contains more than 90 papers about the ecology and management of pinyon-juniper ecosystems. A variety of viewpoints, including scientist, manager, and even Native American are expressed.

The proceedings of that conference and many other sources served as a basis for another Intermountain Research Station publication, *Management of pinyon-juniper woodlands*, General Technical Report–249. Published in June of 1988, this manual is a current state-of-the-art summary and compilation of information on the ecology and management of pinyon-juniper woodlands. It is intended for use by land managers, natural resource management students, and users of the woodlands, and will serve as a basic reference for the upcoming practitioners workshops.

"The work of the committee is a good example of planned-out and carried-out information transfer," Everett said. "When we organized the conference three years ago, we knew we'd go to the step of holding the workshops. And after several rounds of workshops we'll know more about successful management strategies. By then we'll be ready to develop substantive management guidelines for the pinyon-juniper type in the Intermountain West."

In addition to developing the classification system, scientists in the project have examined basic woodland ecology and used this information to develop more ecologically feasible management strategies. They have found woodlands differ from forests in rate of nutrient cycling and relative sizes of nutrient pools. Because a greater proportion of the site nitrogen is found in woodland litter and slash than in forests, the nutrient balance is more precarious, and indiscriminant slash burning unwarranted.

Building the cheapest fence

"Managers have had limited success when trying to apply 'big forest' procedures to the woodlands," said Everett. Wanting to burn all the slash is a good example. For successful site revegetation to desirable forage species, we instead recommend lopping and scattering the slash. The boughs and needles provide a good safe site for broadcast seed."

"These lands are grazing lands; you must protect seedlings from animals until plants are established. Slash is the cheapest fence you can build."

Even after the workshops help solidify management guidelines, Everett sees the continuing need for research in pinyon-juniper type.

Favorable habitat for deer in pinyon-juniper woodlands is dependent on open areas in the woodlands with browse and forage plants and adjacent cover areas of trees.

"We need to refine the classification, to even more accurately determine the best use of individual sites," he said, "and we really know very little about pine nuts, one of the most important woodland products. Christmas trees are another product about which we can develop better information, such as what is the minimum rotation cycle. There is money to be made in pinyon Christmas trees—you know that when you hear reports of people stealing them by the truck load."

And Everett sees the need for research becoming even more critical in the next 20 years.

"Another energy crisis will greatly increase the population pressure on the woodlands," said Everett. "How many of the people searching for fuelwood will be able to cut down big timber? Instead they will look to the woodland."

"Energy crisis or no, we know the future demand on woodlands will increase", said Everett. "Since it takes 100 years to grow a tree crop, let us be wise in what we do with our standing trees now."

For more information contact: Project Leader, Renewable Resources Center, University of Nevada Reno, 920 Valley Rd., Reno, NV 89512

Kiss of death for mistletoes

by Frank Hawksworth and Rick Fletcher
Rocky Mountain Station

Application of ethephon with a hydraulic sprayer on mistletoe-infested lodgepole pine, Colorado.

Dwarf mistletoes have long been recognized as one of the most widespread and damaging diseases of conifers in western North America (see *Forestry Research West,* November, 1988). These parasitic plants reduce height and diameter growth rates of their host trees, increase mortality, decrease cone and seed crops, reduce wood quality, and predispose trees to attack by insects and other diseases. Dwarf mistletoes affect more than half of some National Forests in the Central Rockies (ponderosa and lodgepole pines) and Southwest (ponderosa pine and Douglas-fir).

Although effective silvicultural controls of these parasites in commercial timber-growing forests have been developed, additional control options have long been needed for high-value trees such as in recreational areas, campsites, and around mountain homes. In timber-growing areas, control methods are applied on a broad stand basis and involve standard silvicultural practices such as thinning, clearcutting, shelterwood cutting, and seed-tree cutting. However, these methods of control are of limited use in recreational forests because of the high ornamental value of individual trees. In high-value areas, more intensive control techniques based on individual trees are suitable. One method that is widely practiced in such stands is pruning infected branches. A drawback of pruning,

however, is that it is only effective in lightly to moderately infected trees (usually only those trees with infection in the lower half of the tree crown). Also, pruning is used primarily to prolong the life of infected trees while a chemical that kills the mistletoe shoots could also help protect adjacent trees.

Dr. Frank Hawksworth, Research Plant Pathologist with the Rocky Mountain Station in Fort Collins says that the search for a safe and effective chemical control for the dwarf mistletoes has been an elusive goal of western forest pathologists for many decades.

Now, for the first time the Environmental Protection Agency has approved a chemical for reducing the spread of these damaging disease agents—a plant growth regulator called ethephon. Ethephon is available under the trade name "Florel", produced by the Rhone-Poulenc Ag Co. Ethephon has the unique ability to cause release of ethylene when it is absorbed by plant tissues. The ethylene causes the mistletoe's aerial shoots to fall off, thus preventing seed maturation and spread. However, it does not affect the mistletoe's root system within the host tissues. Aerial shoots will eventually reappear. But regrowth of the shoots to the point where they can again produce seeds is slow, limiting seed dispersal for 3 or 4 years, or perhaps even longer, before re-spraying would be necessary. Ethephon is a very safe chemical that has been approved for use on several food crops for some time. Also, in most tests to date, the chemical has shown little effect on the host's foliage or on adjacent understory plants. However, if dosages higher than those recommended are applied, some killing of host needles may occur.

Although ethephon was tried on dwarf mistletoes at least 15 years ago, its active testing and development as a practical control has been only during the past few years. In the early 1980's research at the University of Minnesota showed that ethephon effectively killed shoots of Eastern dwarf mistletoe on black spruce. Because of this early promise, Dr. Tom Nicholls, Research Plant Pathologist with the North Central Station in Minnesota, helped establish tests on the widespread and damaging dwarf mistletoe (*Arceuthobium americanum*) on lodgepole pine in Colorado.

Colorado studies

Scientists traveled to the Rocky Mountain Station's Fraser Experimental Forest in central Colorado to conduct their lodgepole pine studies. Trials with dwarf mistletoe (*Arceuthobium vaginatum*) on ponderosa pine were undertaken on the Roosevelt National Forest in the northern part of the State. Between 1983 and 1985, ethephon was applied using three methods: a bottle sprayer, a backpack mistblower, and a hydraulic sprayer. Aerial applications by helicopters were tested on lodgepole pine dwarf mistletoe in 1986 and 1987. Also, an operational ground test using a hydraulic sprayer, as requested by the Sulphur District of the Arapaho-Roosevelt National Forest, was established, in cooperation with Dr. David Johnson of the Forest Pest Management group of the Rocky Mountain Region, in a lodgepole pine stand at Shadow Mountain Reservoir in 1985. Additional ground tests were conducted, in cooperation with Forest Pest Management, on ponderosa pine dwarf mistletoe on the Manitou Experimental Forest, near Colorado Springs in 1987, and in the Black Forest northeast of Colorado Springs in 1988.

Dwarf mistletoe plant on ponderosa pine, Colorado.

The same dwarf mistletoe plant 2 weeks after the application of ethephon showing that all mistletoe shoots have fallen off.

Results

All ground applications that thoroughly wetted the mistletoe plants were effective in killing 80 to 100 percent of the mistletoe shoots. Most of the mistletoe shoots fell off within 2 to 3 weeks after treatment. Mistletoe seed dispersal the year after application was significantly less in treated plots than in untreated plots. The results suggest that lodgepole pine dwarf mistletoe seed production was markedly reduced for up to 4 years after the initial application. The aerial sprays were not effective, presumably because adequate coverage of the mistletoe plants was not achieved.

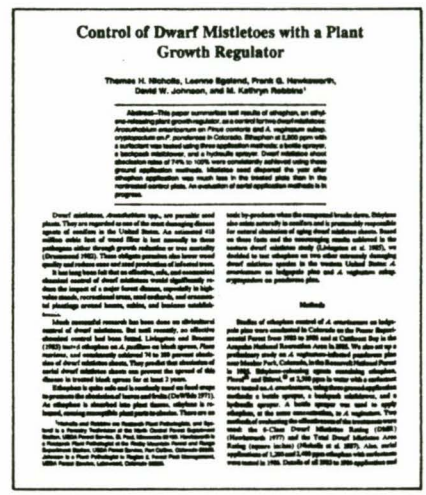
Other tests in the West

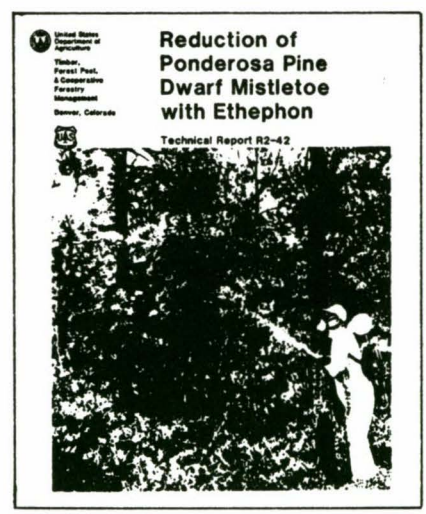
At a recent meeting of Forest Pathologists from throughout the West in Park City, Utah, reports on trials with ethephon on several dwarf mistletoes were compared. Tests are underway on ponderosa pine dwarf mistletoes in New Mexico, Idaho, and Colorado; on Douglas-fir and larch dwarf mistletoes in Oregon;

on pinyon dwarf mistletoe in New Mexico; and on dwarf mistletoes of lodgepole, ponderosa and Jeffrey pines in California. In addition, tests are being conducted on leafy mistletoes (genus *phoradendron*) on hardwood trees in California and Texas. Preliminary results from all these trials indicate that very high mistletoe shoot mortality (approaching 100 percent) can be obtained by thoroughly spraying mistletoe shoots. All tests are being monitored to determine the length of time that seed production is retarded, to help determine the need for subsequent applications.

The bottom line

Ethephon is a safe chemical that can effectively cause dwarf mistletoe shoots to fall off, limiting the mistletoe's spread within the infected tree and to adjacent trees. The growth regulator does not affect the mistletoe's root system within the tree's tissues so it *cannot* be considered a "cure" for the disease. However, repeat applications at 3 to 4 year intervals can greatly minimize dwarf mistletoe spread within and to nearby trees. Because of the relatively high costs of application (approximately $3 to $5 per tree), ethephon is probably limited to high-value trees such as in home sites or recreational areas. Even there, its use should be restricted to protecting stands adjacent to infected stands. An example would be a case where a young stand under an infected overstory needs to be protected until it is large enough to provide the desired cover, and the infected overstory can be removed.


Control of Dwarf Mistletoes with a Plant Growth Regulator



For additional details, the Rocky Mountain Station has copies of the reprint *Control of Dwarf Mistletoes with a Plant Growth Regulator*. The USDA Forest Service Rocky Mountain Region has copies of another informative publication-*Reduction of Ponderosa Pine Dwarf Mistletoe with the Plant Growth Regulator Ethephon,* Technical Report R-2-42. Write to Dave Johnson, Timber, Forest Pest, and Cooperative Forestry Management Unit, USDA Forest Service, 11177 W. 8th Avenue, Lakewood, Colorado 80225, (303) 236-9541, FTS 776-9541.

For additional information on these studies, contact Frank Hawksworth at the Rocky Mountain Station, 240 W. Prospect Rd., Fort Collins, Colorado 80526, (303) 498-1252, FTS 323-1252.

Integrated research in eastern Oregon

by Cynthia Miner
Pacific Northwest Station

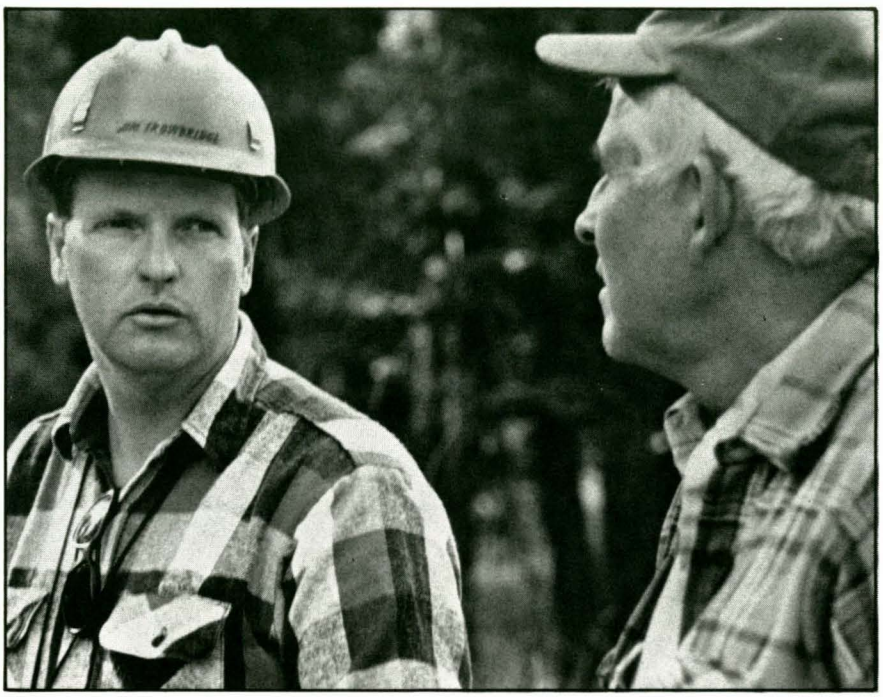
Clear blue skies, hardly a breeze, and cool October temperatures: perfect conditions for applying fertilizer by helicopter. "We're doing fine," says the pilot, "we'll get block 2, too." The helicopter ascends; the bucket under its belly dangles over a truck. Two men fill the bucket; moments later, the pilot pulls a lever that releases tiny white pellets 30 feet over a stand of second-growth grand fir, Douglas-fir, western larch, ponderosa pine, and Engelmann spruce near La Grande, Oregon. On the ground, research technicians from the Pacific Northwest Research Station distribute black plastic bags on the forest floor of plots not yet fertilized; the bags are for checking application rates after the helicopter passes overhead.

Different fields, but mutual-interest in fertilization

Helping the technicians and pilot in applying the fertilization to meet the requirements of the study, and making adjustments as problems arise, are ecologists, forest entomologists, range scientists, and a silvicultural technician. These resource researchers and managers do not, however, represent all fields with interest in the project. Economists, foresters, plant pathologists, soil scientists, and wildlife biologists also want to know what will happen to the fertilized plots in the next several years. A theme repeatedly expressed by all participants is that just as managers can no longer be single-use oriented, researchers can no longer study single resources.

And what makes fertilization worth studying for these researchers and managers? Boyd Wickman, project leader for the integrated pest management group at the Pacific Northwest Research Station, wants to study fertilizer for its potential as a means to control the western spruce budworm. Range scientist Reed Sanderson, Pacific Northwest Research Station, will study

A helicopter releases fertilizer over a study area in eastern Oregon where, in an integrated approach, researchers and managers will discover how fertilizer affects forest pests, forage for wildlife and livestock, tree growth, biodiversity, and more.



Discussing logistics for reserving the study area from nearby management activities are Jim Trowbridge, technician from the Umatilla National Forest, and Dick Mason, insect ecologist from the Pacific Northwest Research Station.

fertilizer as a tool for increasing forage production in range management. The feasibility of using fertilizer for these and-other resource management purposes is likely contingent on integrated use for sharing costs and benefits. Part of the beauty of this study, the scientists explain, is that it brings together three big management concerns on the east side of Oregon: forest pests, livestock grazing, and wildlife. The costs of solving problems in these and other areas can be shared, and potentially management of several resources can share a common tool: fertilization.

Interested in another use, Greg Filip, plant pathologist from the Pacific Northwest Research Station, says he has wanted to look at how Armillaria root disease is affected by fertilizer in the Pacific Northwest for some time, and now he has the opportunity to do so. Work in other parts of the world have shown that root diseases respond to fertilizer. Armillaria is related to tree vigor—trees weakened by insects and other agents are susceptible to attack by the disease. "Since Armillaria has been associated with the budworm, by increasing the vigor of the tree with fertilizer, we should be able to reduce damage by the disease." says Filip.

Jim Trowbridge, silvicultural technician on the Walla Walla Ranger District, has been helping researchers coordinate with managers on the Umatilla National Forest where part of the study area lies. He also has keen interest in the results of the study. "First, I expect to see increased growth on timber, especially in young stands," says Trowbridge. "Second, we'll see how the fertilizer affects the budworm. Are we creating a healthy forest that can defend itself against the insect? It'll be interesting to see if fertilizer is an effective tool we can use in the forest."

Fertilizer effects on budworm prompts study

The western spruce budworm was what initiated the integrated study. In 1984, the Pacific Northwest Research Station, with Oregon State University and Forest Pest Management in Region 6 of the Forest Service, began cooperating on a different study for determining the effects of thinning and nitrogen fertilization on the budworm. In that study, higher budworm densities and heavier individual larvae resulted from application of nitrogen, indicating the budworm prospered. But at the same time, defoliation was significantly reduced on the fertilized trees. The study was designed to see if fertilization would produce foliage that resisted budworm feeding, but no such effect was found. Instead, it produced a new question: Does fertilization create trees that grow more foliage than the budworm can eat? Along with this question came doubts: Will nutrients improve the vigor of the budworm so that the budworm outbreaks will be prolonged?

The first study was limited to small plots on one area. Now, insect researchers and pest managers familiar with the first study want to see how the budworm and trees will respond to fertilizer in other stands and on a larger scale. The new study covers 200 acres with five blocks of 40 acres. Each block is divided into four plots; one of the blocks is a control, one is being treated with 311 pounds of nitrogen per acre; one with a mix of 89 pounds per acre of nitrogen and 22 pounds per acre each of phosphorus, potassium, and sulfur; and the fourth with a mix of 267 pounds per acre of nitrogen and 66 pounds per acre each of phosphorus, potassium, and sulfur.

The helicopter flies between the loading truck and block 2. The study area has been infested by the budworm for about 3 years. A decline in population can be expected in a few years; scientists hope, for the purpose of this study, that the decline does not come sooner. The stands in the study area represent a variety of conditions—different species mixes and various densities. All second growth, the stands also vary in silvicultural treatments; for example, some stands have been thinned and others have not. Land managers in the study area are the Umatilla and Wallowa-Whitman National Forests and Boise Cascade Corporation, which manages land belonging to a private owner.

Researchers at the Pacific Northwest Research Station have been working with the resource managers and landowner in hopes that the study will pay off for all of them. "If we can get trees growing vigorously during an outbreak (6 to 7 years), we may not need to treat with insecticides," says Wickman.

"We think that fertilization may be used as a technique to buy a little time," adds Dick Mason, insect ecologist from the Pacific Northwest Research Station. "Trees could increase growth during an outbreak, reducing its impact and keeping the trees in good shape until the budworm population declines."

"Fertilizing is expensive and couldn't replace treatment with Bt (*Bacillus thuringiensis*)," Wickman points out. "But I think the real value of fertilizing would be in stands where there's already been a high investment, particularly in stands that have been thinned. Some of the most severe budworm damage has been in thinned stands. Combining thinning with fertilization may do the trick. When we treat a stand with Bt, we don't get an increase in tree growth. With fertilizing, we should improve growth of trees and of forage for livestock and wildlife."

The multidisciplinary approach in the study is what most excites Wickman: "Even if we get a negative result about insect control with this study," he says, "we're going to get some very useful information about forest management for the east side of Oregon. It's going to give us a handle on managing the understory for livestock and wildlife. We'll learn some basics about how we change plant and animal diversity by adding nutrients to the system. Diversity might be for the better and it might not. The study is going to also tie into how much site productivity we can manage for on the east side."

As Wickman speaks, the helicopter releases the last bucket of the day. The wind has come up—the helicopter can no longer fly low. The next plot with its floor of grass under a sparse stand will have to wait until another day. Art Tiedemann, supervisory ecologist from the Pacific Northwest Research Station, points out that this sparse stand is part of transitory range—forage that has developed after thinning or harvest. "Here, we have a blend of forest and range ecology," he says.

Integrated use may open door for fertilizer in range management

Transitory range is increasingly sought to relieve pressure on riparian zones abused by overuse from wild and domestic ungulates. Understanding both forest and forage productivity is vital according to Tiedemann. "We can't change the moisture regime in these drier areas, but there is a limiting factor we can deal with, and that's nutrients," he explains.

"One of the options we have for increasing forage production is fertilization," says Tiedemann. "It will probably also change the quality of forage. Some plants will make better use of the nutrients than others, both in trees and the understory." In this study, he and Sanderson will be measuring quantity of forage production, quality relating to what an animal needs and wants, ways nutrients are tied up in the forest floor, how the forest floor affects movement of nutrients, and how much more forage is used. Over the next 3 to 5 years, they expect a two- to three-fold increase in understory productivity from fertilizing, with normal precipitation.

Animals are attracted to fertilized areas, and fertilization can be useful for influencing animal movement. For instance, during seasonal changes, points where animals enter into a forage area could be controlled. "But," Tiedemann says, "it has been difficult to justify fertilization on an economic basis."

"When we combine controlling insects with forest growth and forage production, however," explains Tom Quigley, range scientist from the Pacific Northwest Research Station, who specializes in economics, "fertilizing warrants an investment that singly, individual benefits would not." Quigley will analyze the costs and benefits of fertilizing in the study area.

Response of tree growth to fertilizer is key

Although focusing on their specialties, the ecologists, entomologists, and range scientists identify the growth response of trees as essential in analyzing the feasibility of fertilizer in integrated resource management. In examining how tree bole growth responds to the fertilizer treatments, Pat Cochran, soil scientist from the Bend Laboratory of the Pacific Northwest Research Station, will work with others in the Forest Nutrition Cooperative. The cooperative, with membership from Federal, state, and industrial organizations, has a goal of understanding mineral nutrition of forests and providing response estimates to nutrient amendments in eastern Oregon and Washington, Idaho, and western Montana.

Some large landowners in Washington and Idaho have found fertilizing to be economically feasible on some of their lands and have recently begun operational fertilization based on response estimates (which consider species, stand densities, and site quality characteristics) provided by the cooperative, says member Jim Moore, professor of forest resources at the University of Idaho.

Since 1980, the cooperative has established plots and has been monitoring them for response to fertilizer in eastern Oregon. Other past studies also have examined tree response to fertilizer in the region. These studies have most often focused on ponderosa pine and Douglas-fir. The integrated study, Cochran explains, provides an opportunity for examining how grand fir will respond to fertilizer and for gathering a variety of information that will be useful to silviculturists and to the scientists from other fields working on the study.

Potential for applied and basic research

The methods of the integrated study also allow scientists to examine both applied and basic research questions. "This is a novel thing," Mason says, "it's never been done on this scale.

A bag for measuring application rates is checked by Research Technician Kevin Hosman after the mixed-fir stand was fertilized; the 200-acre study area has five replications of a control and three treatments: nitrogen only and two mixes of nitrogen, phosphorous, potassium, and sulfur.

There's not much in the literature on the effect of fertilizer on insects. Most of the work has shown that insects benefit. But nothing has been done to show the effect on tree growth in an insect outbreak. If this works for the budworm, we'd like to look at it for other pests, such as the Douglas-fir tussock moth and pandora moth."

That's the applied research side. Mason, however, has another more basic interest in this study: How will fertilization affect biological diversity? "We might not find anything," he says. "But I think we have a good chance of finding some changes. Whenever you add a nutrient to a system, it benefits a lot of things." But fertilization is not necessarily positive for all components of an ecosystem. "Adding nutrients like we are could, for example, really upset the underground biotic system," Mason explains.

The scientists now participating in this study would like to see even more researchers take advantage of this accessible 200-acre area that is already dedicated to research for the next 5 years. "We have a natural laboratory for anyone to use," Mason observes. Wickman adds that he and other researchers in the study look forward to using the area as an educational resource, for demonstrating to managers and other researchers what happens to the mixed-conifer ecosystem in eastern Oregon when different types and amounts of nutrients are added.

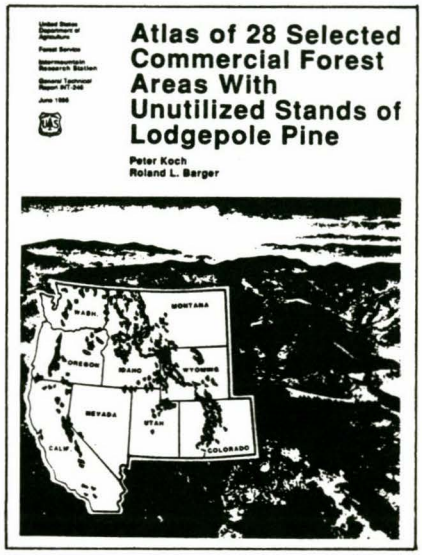
For further information about this study, contact Boyd Wickman, (503) 963-7122, FTS-421-6577, or Forestry and Range Sciences Lab, 1401 Gekeler Lane, La Grande, Oregon 97850. If you would like more information about the Forest Nutrient Cooperative, contact Jim Moore, (208) 885-7421, or Department of Forest Resources, University of Idaho, Moscow, Idaho 83843.

New from research

Problem acreages in lodgepole pine

In the Interior West, lodgepole pine represents the single most significant opportunity for improving both wood resource utilization and forest land management. It occupies about 13 million acres of commercial forest land in the United States. Much of this resource is in older, virtually stagnated stands in which growth rate is very slow and mortality very high. Insect and disease attacks on lodgepole of sawlog size make growing large-diameter trees difficult. More than half the lodgepole pine stemwood cubic volume in the Intermountain West is in trees of subsawlog size. About one-third of the volume is on slopes exceeding 45 percent, and many of the stands are not accessible from existing logging roads.

Processes are needed that will permit large-scale profitable utilization of lodgepole pine of all diameter classes on all terrains. But it is doubtful that such process invention would occur until the extent of the resource is fully understood. A new Intermountain Research Station General Technical Report contributes to this understanding by describing representative problem areas within 28 public forests where increased utilization of lodgepole pine is desired by forest managers. These areas comprise only a small percentage of the total problem acreages of lodgepole pine forests.



Request *Atlas of 28 Selected Commercial Forest Areas with Underutilized Stands of Lodgepole Pine*, General Technical Report INT-246.

Snow damage to ponderosa pine

A new Intermountain Research Station report describes a procedure for predicting potential damage to ponderosa pine plantings due to weight and movement of snowpack. For more than five decades, ponderosa pine has been the preferred species for reforesting burned and cut-over areas in many of the warmer and drier portions of the Northern Rockies. Reports were available on the species' susceptibility to snow in other parts of the West, but no information was previously available for this region.

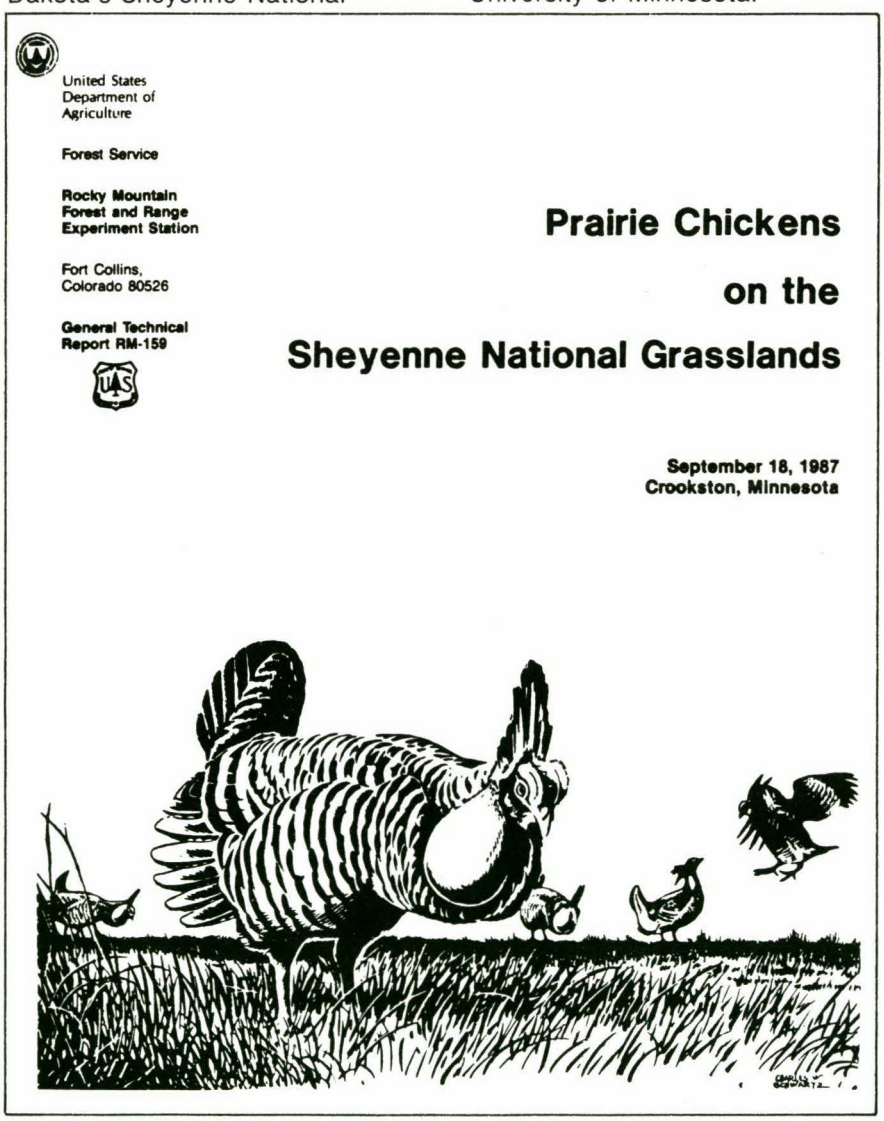
The paper describes a procedure for predicting snow damage potential from site features easily obtained by forest managers. An example of the procedure for field use is included.

Management implications include that seedlings from improper seed sources may be less likely to recover from snow bending. In high-snow-hazard areas, forest managers should consider silvicultural alternatives other than clearcutting and planting ponderosa pine.

Request *A Field Guide for Predicting Snow Damage to Ponderosa Pine Plantations*, Research Note INT-385.

Prairie chicken research compiled

The greater prairie chicken (*Tympanuchus cupido pinnatus*), a naturalized immigrant to the Dakotas, has thrived in North Dakota's Sheyenne National Grasslands, while populations have declined or disappeared in many other regions. These healthy populations have been the subject of considerable research which was compiled for the first time in the "Prairie Chickens on the Sheyenne National Grasslands" Symposium, held last year at the University of Minnesota.



The symposium, part of the 17th Prairie Grouse Technical Conference, brought together researchers, educators, students, managers, and field technicians involved in prairie chicken research and habitat management. The proceedings of the symposium have been published in *Prairie Chickens on the Sheyenne National Grasslands*.

This report contains eight papers and two abstracts of papers presented at the symposium. The papers document and synthesize information gained over the past several years on prairie chicken ecology, habitats, and diets, and effects of cattle grazing on prairie chicken habitat. The proceedings will serve as valuable reference for continued improvements in the management of the habitat of the prairie chicken.

Copies of *Prairie Chickens on the Sheyenne National Grasslands*, General Technical Report RM-159, are available from the Rocky Mountain Station.

Disease affects regeneration of Jeffrey Pine

A disease caused by the fungus *Elytroderma deformans* is widespread on several pine species in western North America. In some years, when weather conditions permit, the disease reaches epidemic proportions on some sites, increasing susceptibility to subsequent insect attacks and mortality. One such area is the southern portion of the Lake Tahoe Basin in California.

Scientists with the Pacific Southwest Station discovered that outbreaks of the disease are relatively infrequent, but that it persists for many years after infection. In their evaluation of young, planted seedlings of Jeffrey Pines, they determined that the disease apparently had no effect on seedling survival or growth over the 14 years of the study. But because terminal shoots were infected in more than half of the diseased seedlings, indicating future impact on survival and height growth, they recommend that on sites with high disease hazard, managers plant conifer species resistant to the disease.

To learn more, contact the Pacific Southwest Station and request Research Note PSW-399, Elytroderma *Disease in Young, Planted Jeffrey Pine, South Lake Tahoe, California.*

Measuring population density and condition of wild ungulates

Measures of performance in wild ungulates must consider condition and health of individuals along with estimates of population density. Condition and health interact with population through such factors as diet and nutrition, as well as cover, weather, hunting, human disturbance, predation, territoriality, competition, availability of water, and others.

A recent publication issued by the Pacific Southwest Station describes some current methods for measuring population densities, condition, and health in wild ungulates and suggests some appropriate techniques to the resource manager, along with sufficient references to allow further study.

To request this report, contact the Pacific Southwest Station and ask for General Technical Report PSW-106, *Performance in Wild Ungulates: Measuring Population Density and Condition of Individuals.*

A look at user pays systems

Faced with growing recreational demands and cutbacks in funding, many land managers have turned to a "user pays" system of generating revenue. Such systems often charge admission fees, concession and facility rental fees, and collect special taxes to offset administration costs.

Colorado State University professor Robert Aukerman has studied user pays systems and authored a new book, *User pays for Recreation Resources*. The 340 page book serves as a comprehensive reference for government, managers, boards, planners, and consultants facing recreation funding decisions. It considers the history, methods, public responses, and future trends of user pays systems, and offers the only comprehensive and current look at what Federal, State, local, and private agencies are doing and have learned from changing user fees.

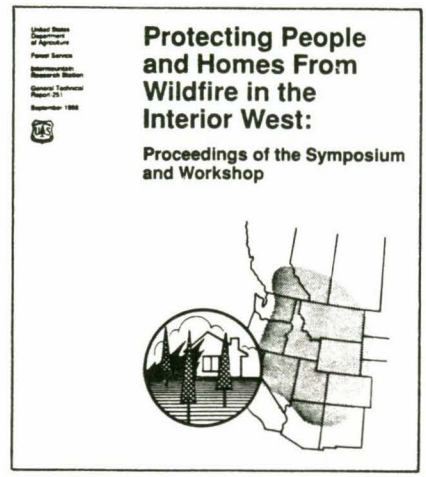
User Pays for Recreation Resources is published by Colorado State University and is available for $29.95. Copies can be obtained by writing: User pays, 729 Duke Square, Ft. Collins, CO 80525, or calling (303) 491-5511.

Wildfire's threat to people and homes—new information

In the last three years, wildfires in the United States destroyed more than 2,400 homes and burned substantial amounts of other private property. And with three dry summers already passed and no drought relief in sight, the wildfire threat to homes in forested suburbs in the West may be just beginning.

The Intermountain Research Station recently issued *Protecting People and Homes from Wildfire in the Interior West*, a publication summarizing knowledge by experts on the wildfire-home problem. It includes recommendations for homeowners, government agencies, fire assistance personnel, and the business community.

The report features papers and accounts of workshop discussions from a symposium held in October, 1987, at the University of Montana. The meeting attracted over 500 people; bringing together diverse groups responsible for, or concerned with, the protection of people and homes from wildfire. These included city and rural fire departments, State



and Federal fire control and management personnel, State service foresters, extension agents, professional tree services, land developers, home builders, homeowner associations, county and State officials, mortgage lenders, and insurance industry professionals.

For a copy of the report, request *Protecting People and Homes from Wildfire in the Interior West*, General Technical Report INT–251.

Make a portable rocket-net system

Rocket-propelled nets are an effective and essential tool for capturing waterfowl, deer, turkey, birds of prey, and other wildlife for research. They are particularly useful under trapping conditions requiring flexibility and portability. The construction, use, and safety of these systems has been studied and new experimental systems and firing units have been tested by Rocky Mountain Station researchers.

A portable Rocket-Net System for Capturing Wildlife, Research Note RM-484, presents an analysis of standard 3-rocket net systems, and tests the effectiveness of an experimental 2-rocket system developed and refined from earlier, unpublished designs of the Pennsylvania Game Commission and New York Department of Environmental Conservation.

The experimental system is smaller and lighter than traditional 3-rocket designs and can be carried by 2 people and set up in 20 minutes. The smaller system has a limited range, however, and may be ineffective in some trapping situations. A materials list and diagrams are included for construction of systems, as is a procedural checklist for proper operation.

Caspar Creek video available for loan

A recently-completed 20 min. video program on the response of a coastal watershed to logging and roadbuilding is now available for loan from a California film library.

The program describes a long-term study being carried out by scientists from the Forest Service's Pacific Southwest Research Station. The study site is located at Caspar Creek, on the Jackson State Demonstration Forest, which is managed by the California State Department of Forestry and Fire Protection. The study is being carried out on steep, forested slopes located on the California coast south of Ft. Bragg, an area which receives a great deal of precipitation.

Phase I of the project has been completed and results are described in this program. When completed in 1994, the study will contrast the effects of different logging and roadbuilding methods in two watersheds. (Refer to the previous article on Caspar Creek in the August 1987 issue of *Forestry Research West.)*

This program will be of interest to audiences with at least a basic knowledge of resource management. To borrow the tape, contact: Film Library, Audience Planner, Inc., 5107 Douglas Fir Dr., Calabasas, California 91302.

Bugs on shrubs

Changes in the general image and economic importance of rangelands have intensified the need for a broader knowledge of rangeland biology. Requests to use rangelands for recreation, increased food production, development of energy-producing products, deposits for nuclear wastes, or military and other uses have resulted in the legal requirement of environmental impact statements. For making a knowledgeable judgment, limited information exists on how such activities may interact with the biology of rangeland insects.

Index to Information on Insects Associated with Western Wildland Shrubs provides a brief summary of available information on rangeland insects and an index system with which to access information from published literature and insect collection records. The report contains four major information sections: bibliography, collection, insect, and plant. Each section is divided into listings and indexes that make it easy to find information on a specific topic. Rangeland managers, extension agents, and scientists will find this publication a useful tool for improving present insect management, in setting research priorities, and in planning experimentation.

For a copy, request General Technical Report INT-248 from the Intermountain Research Station.

Conservation Reserve Program analyzed

The Conservation Reserve Program (CRP), created in the Food Security Act of 1985, will place up to 45 million acres of erodible cropland under permanent cover for 10 years. Although potentially one of the most expensive USDA programs in history, the CRP provides opportunities to reduce soil erosion, enhance wildlife habitat, stimulate components of the farm economy, and reduce commodity surpluses.

The Colorado Section of the Society for Range Management sponsored a symposium in September 1987 to examine the program in terms of its ramifications on soil conservation, agriculture, and society. The symposium was designed to look at the CRP's future, and to stimulate thinking about courses of action that will enhance opportunities for achieving the program's goals. While discussion is focused primarily on the Great Plains, the opportunities and problems addressed apply equally to other parts of the U.S.

Proceedings of the symposium, *Impacts of the Conservation Reserve Program in the Great Plains*, General Technical Report RM-158, are available from the Rocky Mountain Station.

To order any of the publications listed in this issue of *Forestry Research West*, use the order cards below. All cards require postage. Please remember to use your Zip Code on the return address.

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4. *Protecting People and Homes from Wildfire in the Interior West*, General Technical Report INT-251.
5. *A Field Guide for Predicting Snow Damage to Ponderosa Pine Plantations*, Research Note INT-385.
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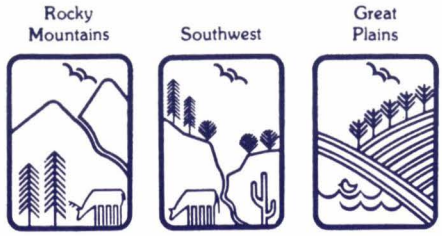
Making artificial snow

Natural snow is formed in very complex shapes which tend to fuse together and recrystalize into different shapes in snowpacks. These complex, varying shapes cause many problems for scientists studying ice surface chemistry, and may account for the great fluctuation in natural snow study results.

Scientists at the Rocky Mountain Station have developed an artificial snow-making apparatus that may help researchers obtain more consistent results. This device uses a sonic nebulizer to produce very uniform ice spheres for laboratory experimentation.

Making Artificial Snow for Laboratory Use, Research Note RM-486, illustrates the apparatus and discusses the improvements it will make to snow chemistry research. Copies are available from the Rocky Mountain Station.



Research Note RM-486

August 1988

USDA Forest Service

Rocky Mountain Forest and Range Experiment Station

Making Artificial Snow for Laboratory Use

Richard A. Sommerfeld and Tara L. Freeman[1]

Ice spheres with a mean radius of 100 micrometers can be produced using a sonic nebulizer at 20 kHz. A collection of these spheres makes a very uniform type of artificial snow that is useful for laboratory experiments.

Keywords: snow, ice

Many studies have shown anomalous surface effects on ice because of quasi-liquid surface layer (Fletcher 1970, Adamson 1982, Sommerfeld and Lamb 1986). A quantitative understanding of ice surface chemistry has not yet been developed. Studies to develop such an understanding depend on a source of ice having a well-defined and high ratio of surface area to volume similar to that of natural snow. However, natural snow starts as very complex, vapor-grown shapes. In a snowpack, snow particles tend to fuse together and recrystallize, changing the shape (Sommerfeld and LaChapelle 1970). Problems associated with these complex shapes contribute to the large scatter in the data from studies on natural snow. Thus, studies that are dependent on having a well-defined surface area are better achieved by utilizing artificial snow.

We have designed a system for producing a consistent type of artificial snow that has given reproducible results when tested with Darcy permeability measurements of specific surface area (Sommerfeld, in prep.[2]). Data are reliable and can be replicated to a degree of accuracy much higher than those produced by previous studies. The utilization of artificial snow will aid in acquiring accurate ice surface chemistry data.

Equipment

The water source in this system was a Barnstead Nanopure II[3] ion exchange system that provided 18 megohm water. The Styrofoam chamber prevented stray air currents from disturbing the stream of droplets. A Dewar flask filled with liquid nitrogen was located in the bottom of the chamber to catch and freeze the water droplets (fig. 1).

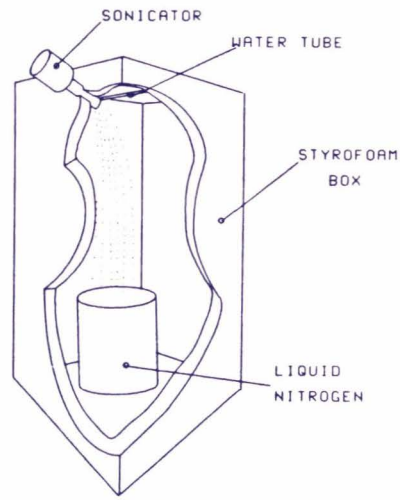


Figure 1.—Schematic diagram of the snow apparatus made of 3-inch Styrofoam (front view).

[1] *Geologist and summer participant in 1890 program, Rocky Mountain Forest and Range Experiment Station. Headquarters is in Fort Collins, in cooperation with Colorado State University.*

[2] *Sommerfeld, R. A. In prep. The Darcy permeability of high density artificial snow.*

[3] *The use of trade and company names is for the benefit of the reader; such use does not constitute an official endorsement or approval of any service or product by the U.S. Department of Agriculture to the exclusion of others that may be suitable.*

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